Ultrasensitive nano-optomechanical force field sensor at dilution temperatures

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An ultrasensitve force field sensor based on the optical readout of suspended vibrating nanowires has been successfully operated at dilution temperatures (Fig. 1). The development of measurements techniques operating in the photon counting regime, where less than one photon is detected per oscillation period, enabled to measure the thermal noise of a nanomechanical resonator thermalized to the base temperature of a dilution fridge. Realizing noise thermometry by varying optical readout powers permits to investigate the unexplored thermal and mechanical properties of the nanowire at dilution temperatures (Fig1.d).

Despite the modest quality factors achieved, limited for the moment by residual amorphous defects contribution, this approach enables unprecedented force readout sensitivities, in the zeptonewton range. In parallel, a novel cavity nano-optomechanical experiment was developed at room temperature, consisting in inserting a nanowire in the middle of a high-finesse fiber-cavity. The combination of dilution temperatures and high-finesse microcavities opens the door towards unexplored regimes in cavity optomechanics, where optical non-linearity arises at the single photon level.

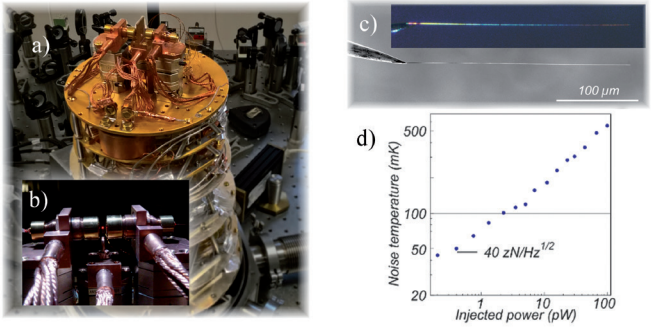

Fig. 1: a) Cryostat CRYOPTICS b) Optical element to inject light and perform the readout c) SiC Nanowire d) Effective temperature and force sensitivity of the sensor.

OUTCOMES

[1] Ultrasensitive nano-optomechanical force field sensor at dilution temperatures, in preparation, (2018)

Oral presentation: GDR MecaQ, Paris, France, 2017

Collaborations: W. Wernsdorfer, E. Eyraud, C. Felix, J. Reichel (ENS-Paris)

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